Quaternary International 290-291 (2013) 264–274

Contents lists available at SciVerse ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Holocene climate conditions in central Yakutia (Eastern Siberia) inferred from sediment composition and fossil chironomids of Lake Temje

Larisa Nazarova [a,b,*], Herman Lüpfert [a], Dmitry Subetto [c], Ludmila Pestryakova [d], Bernhard Diekmann [a]

[a] Alfred Wegener Institute for Polar and Marine Research, Research Unit Potsdam, Telegrafenberg A43, 14473 Potsdam, Germany
[b] Kazan Federal University, Kremlyovskaya Street 18, 420018 Kazan, Russia
[c] St. Petersburg Gerzen Pedagogical University, Moika 48, 191186 St. Petersburg, Russia
[d] North-Eastern Federal University, 58 Belinsky Street, Yakutsk 677891, Russia

ARTICLE INFO

Article history:
Available online 14 November 2012

ABSTRACT

A 380 cm long sediment core from Lake Temje (central Yakutia, Eastern Siberia) was studied to infer Holocene palaeoenvironmental change in the extreme periglacial setting of eastern Siberia during the last 10,000 years. Data on sediment composition were used to characterize changes in the depositional environment during the ontogenetic development of the Lake Temje. The analysis of fossil chironomid remains and statistical treatment of chironomid data by the application of a newly developed regional Russian transfer functions provided inferences of mean July air temperatures (T_{July}) and water depths (WD). Reconstructed WDs show minor changes throughout the core and range between 80 and 120 cm. All the fluctuations in reconstructed water depth lie within the mean error of prediction of the inference model (RMSEP = 0.35) so it is not possible to draw conclusions from the reconstructions. A qualitative and quantitative reconstruction of Holocene climate in central Yakutia recognized three stages of palaeoenvironmental changes. The early Holocene between 10 and 8 ka BP was characterized by colder-than-today and moist summer conditions. Cryotextures in the lake sediments document full freezing of the lake water during the winter time. A general warming trend started around 8.0 ka BP in concert with enhanced biological productivity. Reconstructed mean T_{July} were equal or up to 1.5 °C higher than today between 6.0 ka and 5.0 ka BP. During the entire late Holocene after 4.8 ka BP, reconstructed mean T_{July} remained below modern value. Limnological conditions did not change significantly. The inference of a mid-Holocene climate optimum supports scenarios of Holocene climatic changes in the subpolar part of eastern Siberia and indicates climate teleconnections to the North Atlantic realm.

1. Introduction

The reconstruction of past Holocene environments is important for understanding of the background of natural climate variability underlying anthropogenic influences on climate change. Though the timing of Holocene climate change is well established for wide parts of the Northern Hemisphere (Mayewski et al., 2004), suitable palaeoenvironmental records are still scarce in the Russian Siberian Arctic and sub-Arctic, due to such factors as complex periglacial landscape history, low sedimentation rates in sedimentary archives, and logistical challenges for field work in the remote and extreme periglacial environment (Hubberten et al., 2004; Schirrmeister et al., 2011).

At the present state of knowledge, biological indicators from aquatic (chironomids, diatoms, ostracods, cladocera) and terrestrial environments (pollen, plant macrofossils) are the most reliable proxies, because they react sensitively to climate change and define different aspects of environments, which should be assessed together for reliable reconstructions (Smol et al., 2005; Solovieva et al., 2005, 2008; Kienast et al., 2011; Self et al., 2011; Palagushkina et al., 2012; Pestryakova et al., 2012). The basis, however, of all quantitative reconstruction approaches are regional calibration datasets from which the empirical reconstruction models (i.e. the transfer functions) are established. There are few examples of quantitative palaeoclimate reconstructions in Siberia, and those are mainly from pollen studies (Andreev and Klimanov, 2005; Müller et al., 2009; Andreev et al., 2011; Tarasov et al., 1999, 2009). To date, there is only one quantitative temperature reconstruction inferred from aquatic diatoms in central Siberia (Kumke et al., 2004). Quantitative reconstruction of T_{July} inferred

* Corresponding author. Alfred Wegener Institute for Polar and Marine Research, Periglacial Research, Telegrafenberg A43, 14473 Potsdam, Germany.
E-mail address: larisa.nazarova@awi.de (L. Nazarova).

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http://dx.doi.org/10.1016/j.quaint.2012.11.006